Chronic Multisymptom Illness: A Comparison of Iraq and Afghanistan Deployers With Veterans of the 1991 Gulf War

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1. REPORT DATE **02 DEC 2014**	2. REPORT TYPE		3. DATES COVERED
4. TITLE AND SUBTITLE **Chronic Multisymptom Illness: A Comparison of Iraq and Afghanistan Deployers with Veterans of the 1991 Gulf War**			5a. CONTRACT NUMBER
			5b. GRANT NUMBER
			5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)			5d. PROJECT NUMBER
			5e. TASK NUMBER
			5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **Naval Health Research Center,140 Sylvester Rd,San Diego,CA,92106-3521**			8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)			10. SPONSOR/MONITOR'S ACRONYM(S)
			11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution unlimited.

13. SUPPLEMENTARY NOTES

14. ABSTRACT

Symptoms and illness reported from the Gulf War era are a cause of potential concern for those military members who have deployed to the Gulf region in support of contingency operations in Iraq and Afghanistan. This study quantified self-reported symptoms from Millennium Cohort participants, enrolled in a prospective study representing all US service branches, active duty and Reserve/Guard components, from 2001-2008. Self-reported symptoms were uniquely compared to a cohort from the 1991 Gulf War to gain context for the current report. Symptoms were then aggregated to identify cases of chronic multisymptom illness (CMI) based on the Centers for Disease Control and Prevention case definition. The prevalence of self-reported CMI symptoms was compared to those from a study population of US Seabees from the 1991 Gulf War collected in 1997-1999, as well as deployed and non-deployed subgroups. Although overall symptom reporting was much less than in the 1991 Gulf War cohort, increased CMI reporting was noted among deployed compared to non-deployed contemporary Cohort members. An increased understanding of coping skills and resilience, and well-designed screening instruments, along with appropriate clinical and psychological follow-up for returning veterans, may help to focus resources on early identification of potential longterm chronic disease manifestations.

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES **14**	19a. NAME OF RESPONSIBLE PERSON
a. REPORT **unclassified**	b. ABSTRACT **unclassified**	c. THIS PAGE **unclassified**			

Original Contribution

Chronic Multisymptom Illness: A Comparison of Iraq and Afghanistan Deployers With Veterans of the 1991 Gulf War

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Symptoms and illnesses reported by veterans of the 1991 Gulf War era are a cause of potential concern for those military members who have deployed to the Gulf region in support of more recent contingency operations in Iraq and Afghanistan. In the present study, we quantified self-reported symptoms from participants in the Millennium Cohort Study, a prospective study representing all US service branches, including both active duty and Reserve/National Guard components (2001–2008). Self-reported symptoms were uniquely compared with those in a cohort of subjects from the 1991 Gulf War to gain context for the present report. Symptoms were then aggregated to identify cases of chronic multisymptom illness (CMI) based on the case definition from the Centers for Disease Control and Prevention. The prevalence of self-reported CMI symptoms was compared with that collected in 1997–1999 from a study population of US Seabees from the 1991 Gulf War, as well as from deployed and nondeployed subgroups. Although overall symptom reporting was much less in the Millennium Cohort than in the 1991 Gulf War cohort, a higher prevalence of reported CMI was noted among deployed compared with nondeployed contemporary cohort members. An increased understanding of coping skills and resilience and development of well-designed screening instruments, along with appropriate clinical and psychological follow-up for returning veterans, might help to focus resources on early identification of potential long-term chronic disease manifestations.

Gulf War syndrome; illnesses in Gulf War Veterans; multisystem illness; symptom self-reporting

Abbreviations: CMI, chronic multisymptom illness; PTSD, posttraumatic stress disorder.

More than a decade after the 1991 Gulf War, veteran and public concern continue regarding the health of veterans who returned from that conflict. Although few objective health outcomes have been associated with deployment to the 1991 Gulf War (1–4), as many as 15%–30% of the nearly 700,000 returning 1991 Gulf War veterans have reported a wide constellation of symptoms that have been difficult to classify but were more frequently reported in that group than in their military peers (5–16). Although multiple research teams and numerous expert panels were unsuccessful in clearly implicating any specific deployment exposure as a cause of postwar symptoms, it remains a concern because of the recent prolonged US military presence in the region. Medical experts have suggested that increased symptoms are the result

of battle stressors associated with war-zone experience(s) (17) and that symptoms in Gulf War veterans are consistent with those reported after previous wars, although little data exist for adequate comparisons (5, 18).

Some of the major research challenges after the 1991 Gulf War included the retrospective and cross-sectional assessment of symptoms, lack of objective exposure information years after the end of the war, lack of predeployment behavioral and health data, and investigations limited to narrow subsets of veteran populations, such as active-duty personnel who remained on active duty throughout the study period. Our population-based study was designed to serially assess self-reported symptoms, illnesses, exposures, and some health-risk behaviors (such as tobacco and alcohol use) across all

military service branches and components, including active duty, Reserve, and National Guard service members both on active duty and after separation from the military. Using the Millennium Cohort Study's self-reported data on specific symptoms and illnesses from baseline and follow-up questionnaires, along with deployment and occupational data, we investigated the prevalence of chronic multisymptom illness (CMI) over time and its association with deployment exposures, such as combat experiences and deployment length. Additionally, our study compared the prevalence of CMI in those deployed to the recent military conflicts to that in veterans of the 1991 Gulf War.

METHODS

Study population

The Millennium Cohort Study was launched in 2001 to gather and evaluate deployment, demographic, behavioral, and occupational characteristics related to military service and various health outcomes (19–21). The first panel of invited participants was randomly selected from US military personnel who were serving in October of 2000. Persons who had been previously deployed to Bosnia, Southwest Asia, or Kosovo between 1998 and 2000, Reserve and National Guard members, and women were oversampled. The methodology of the Millennium Cohort Study has been described elsewhere in detail (19–21). Of the 77,047 consenting participants enrolled in the study's first panel, 55,021 (71%) completed the first follow-up questionnaire between 2004 and 2006 and 54,790 (71%) completed the second follow-up questionnaire between 2007 and 2008.

Similar to the first panel, the second panel of invited participants was randomly selected from military personnel with 1–2 years of service as of October 2003. Marines and women were oversampled in this panel. There were 31,654 participants who consented and were enrolled in the study's second panel between 2004 and 2006, with 17,152 (54%) completing the follow-up questionnaire between 2007 and 2008. The population for this study included participants from the first and second panels of the Millennium Cohort Study who completed a baseline questionnaire and at least 1 follow-up questionnaire and had complete demographic, occupational, CMI-related, and other selected covariate data.

Data collection

Demographic and military-specific data were obtained from the Department of Defense Manpower Data Center and included sex, birth date, highest educational level, marital status, race/ethnicity, deployment in support of wars in Iraq and Afghanistan, pay grade, service component, service branch, and military occupation. Data regarding symptom prevalence among 1991 Gulf War Seabees (hereafter referred to simply as Seabees) were obtained from The Seabee Health Study (9).

Deployment information and cumulative length deployed identified from electronic personnel data and self-reported combat experience were used to assess deployment experience in support of the operations in Iraq and Afghanistan at the baseline and follow-up assessments. Individual exposure to combat while deployed was assessed at each time point by asking if the participant had personally experienced any of the following in the past 3 years: "witnessing a person's death due to war, disaster, or tragic event," "witnessing instances of physical abuse (torture, beating, rape)," "dead and/or decomposing bodies," "maimed soldiers or civilians," and "prisoners of war or refugees" (22). Possible responses to this question included "yes, 1 time," "yes, more than 1 time," or "no." If a participant responded affirmatively to any of the above statements and was deployed at least once in the 3 years before survey completion, they were categorized as "deployed with combat." Otherwise, they were categorized as "deployed without combat." If the participant did not deploy 3 years before their survey date, they were classified as a "nondeployer" for that time period. Deployment history in support of the recent operations was assessed in the 3–6 year time period before survey completion using the same method described above. Cumulative deployment was calculated by summing the number of days a service member was deployed in support of the wars in Iraq and Afghanistan in the 3 years before each survey completed.

Alcohol-related problems were identified using the Primary Care Evaluation of Mental Disorders Patient Health Questionnaire (23). Participants who reported events such as "drove a car after having several drinks or after drinking too much" as having happened more than once in the past 12 months were classified as having alcohol-related problems (24–27). Participants were categorized as nonsmokers, past smokers, or current smokers based on questions about current and lifetime smoking behaviors (28). The Posttraumatic Stress Disorder (PTSD) Checklist-Civilian Version was used to assess PTSD with criteria established by the *Diagnostic and Statistical Manual of Mental Disorders, 4th Edition* (29, 30). The Patient Health Questionnaire provided a psychosocial assessment based on scores of several health concepts. Using the standardized Patient Health Questionnaire scoring mechanisms, depression and panic or other anxiety syndromes were assessed (23, 31, 32).

Outcomes

Our study first evaluated self-reported symptoms of 18 health conditions that have been reported to be higher among veterans of the 1991 Gulf War (9). These clinical signs and symptoms included severe headache; diarrhea; rash or skin ulcer; sore throat; night sweats; chest pain; unusual muscle pains; shortness of breath; trouble sleeping; unusual fatigue; sudden unexplained hair loss; being sleepy all the time; forgetfulness; stomach pain; pain in the arms, legs, or joints; cough; feeling down, depressed, or hopeless; and feeling nervous, anxious, or on edge or worrying about a lot about different things. Assessment of symptom reporting in the Seabees Study matched exactly or was closely matched to that in the Millennium Cohort Study, as shown in Table 1.

Further, to establish the presence of CMI, we used the Centers for Disease Control and Prevention definition, in which subjects were determined to have CMI if they reported at least 1 symptom in at least 2 of the following 3 symptom constructs: 1) general fatigue, 2) mood and cognition abnormalities, and

Table 1. Prevalence of Symptom Reporting Among 1991 Gulf War Seabees (1997–1999) and Millennium Cohort Study Participants (2001–2008), by Deployment Status

Self-Reported Symptom	Seabees[a], %		Millennium Cohort Study Participants[b,c], %							
	Nondeployed (n = 3,104)	Gulf War Deployed (n = 3,831)	Total Study Population[d]		Nondeployed		Deployed Without Combat		Combat Deployed	
			2004 (n = 65,566)	2007 (n = 65,926)	2001–2004[e] (n = 32,449)	2004–2007[f] (n = 44,342)	2001–2004[e] (n = 6,883)	2004–2007[f] (n = 9,481)	2001–2004[e] (n = 6,735)	2004–2007[f] (n = 10,873)
Matched exactly										
Severe headache	9.8	26.9	16.5	19.3	17.0	18.9	13.3	15.8	20.5	23.6
Diarrhea	6.8	24.0	10.0	11.4	9.0	10.1	8.1	9.0	18.1	17.6
Rash or skin ulcer	5.1	22.4	7.4	8.8	7.7	8.1	6.6	7.0	12.3	12.4
Sore throat	5.7	16.0	9.3	9.8	8.8	9.1	7.2	8.4	12.4	12.6
Night sweats	4.6	17.1	8.8	12.3	9.8	12.3	6.2	7.1	11.1	15.4
Chest pain	5.1	16.0	6.4	7.6	6.4	7.4	4.7	5.5	8.8	9.5
Unusual muscle pains	5.7	22.6	9.7	12.3	10.3	11.9	7.4	8.0	14.2	16.1
Shortness of breath	4.5	16.1	8.2	9.9	8.1	9.5	6.6	6.9	11.8	12.4
Trouble sleeping	15.5	38.6	22.8	29.8	22.1	28.3	17.7	21.5	32.6	40.7
Unusual fatigue	13.4	38.9	14.5	18.2	14.8	17.4	12.4	12.6	21.2	24.2
Closely matched[g]										
Sudden hair loss[h]	1.8	6.4	2.6	3.0	2.6	2.9	1.6	2.3	3.7	3.7
Sleepiness[i]	6.8	22.6	13.6	16.0	12.7	15.3	11.4	13.2	17.5	20.7
Short-term memory problems[j]	12.9	39.5	16.9	21.5	16.9	20.0	15.4	16.5	24.7	29.8
Stomach pain or ulcer[k]	4.4	13.4	15.4	16.5	15.0	16.4	12.7	13.4	18.2	18.5
Joint pain[l]	13.6	37.9	47.0	51.7	48.9	51.4	44.1	44.3	55.3	57.5
Continual cough[m]	3.2	9.5	10.9	12.3	9.9	11.3	9.5	10.3	16.1	16.8
Depression[n]	6.0	17.7	20.2	22.9	19.1	22.4	14.9	17.6	23.4	27.8
Chronic worry or anxiety[o]	6.3	17.9	32.9	33.8	31.7	33.3	26.5	26.6	38.4	41.2

[a] Seabees were veterans of the 1991 Gulf War. Symptoms were self-reported in May 1997–July 1999.

[b] Each Millennium Cohort Study participant was required to answer at least 1 symptom question at both baseline and follow-up to be included in this study. However, the total number of participants who answered each specific symptom question varied, so the prevalence of affirmative responses is based on the number of people who responded to the specific question.

[c] Deployment in support of the recent conflicts in Iraq and Afghanistan.

[d] Includes participants enrolled in 2001 (panel 1) and 2004 (panel 2) to assess symptom prevalence at each survey cycle in which both panels were eligible to complete a survey (2004 and 2007).

[e] Includes only those participants enrolled in 2001 (panel 1) because combat deployments cannot be assessed at baseline for participants enrolled in 2004 (panel 2). Symptoms were assessed at the 2004 follow-up survey cycle.

[f] Includes participants enrolled in 2001 (panel 1) and 2004 (panel 2). Symptoms were assessed at the 2007 follow-up survey cycle.

[g] These self-reported symptoms were worded differently on the Seabee Health Study survey versus the Millennium Cohort Study surveys. Symptom wording listed in the table was from the Seabee survey.

[h] Millennium Cohort Study wording was "sudden unexplained hair loss."

[i] Millennium Cohort Study wording was "sleepy all the time."

[j] Millennium Cohort Study wording was "forgetfulness."

[k] Millennium Cohort Study wording was "stomach pain."

[l] Millennium Cohort Study wording was "pain in your arms, legs, or joints."

[m] Millennium Cohort Study wording was "persistent or recurring cough."

[n] Millennium Cohort Study wording was "feeling down, depressed, or hopeless."

[o] Millennium Cohort Study wording was "feeling nervous, anxious, on edge, or worrying a lot about different things."

3) musculoskeletal pain (6, 7, 33). General fatigue was considered to be present when participants reported that they had "unusual fatigue." Mood and cognition was assessed through the presence of any of the following symptoms: "feeling down, depressed, or hopeless," "problems with forgetfulness," "difficulty concentrating," "feeling irritable or having angry outbursts," "feeling nervous, anxious, on edge, or worrying about a lot of different things," "confusion," and "trouble falling or staying asleep." The musculoskeletal construct included the following 2 symptoms: "pain in your arms, legs, or joints (e.g., knees, hips)" and "unusual muscle pain." CMI was assessed at each time point.

Statistical analyses

Frequencies of affirmative responses to questions about the presence of the 18 symptoms were compared with those previously reported by Seabees in the Seabee Health Study (9). Unadjusted analyses, including χ^2 tests, were used to calculate measures of the associations of CMI with deployment, occupational, demographic, and behavioral risk factors. Using the 2003 US military population proportions of birth year, sex, race/ethnicity, educational level, and pay grade, weighted CMI prevalence was computed using the inverse response method (34).

As a result of correlated outcome data, adjusted associations between deployment and CMI were determined using generalized estimating equations (35). These analyses accounted for both covariates fixed at baseline (sex, birth year, race/ethnicity, educational level, service branch, service component, occupation) and those that were time-varying and assessed at the previous survey (marital status, deployment status, smoking status, alcohol-related problems, panic or other anxiety disorders, depression, PTSD, history of CMI). Significant associations between CMI and independent variables involved evaluation of potential confounders while adjusting for all other variables. All data analyses were conducted using SAS, version 9.2 (SAS Institute, Inc., Cary, North Carolina).

RESULTS

There were 80,524 participants who completed both a baseline survey and at least 1 follow-up survey. Participants were excluded from this study if there were no data on CMI symptoms because participants had not answered the questions about symptoms ($n = 1,035$), deployment could not be classified because of missing information on combat exposure or the number of deployment days ($n = 296$), or covariate data were missing ($n = 6,115$). This resulted in 73,078 participants available for our analyses.

Data on symptoms reported by the current study population and the Seabees categorized by deployment status are presented in Table 1. Overall, the population of the Millennium Cohort Study reported fewer symptoms than did deployed Seabees. However, joint pain and chronic worry or anxiety were reported at higher levels in the Millennium Cohort Study population than in the Seabees, with combat deployers reporting the highest prevalence of joint pain (57.5%)

and chronic worry (41.2%) at the time of the 2007 survey. Cohort nondeployers reported higher levels of all 18 health conditions than did Seabee nondeployers. Notably, the prevalence of depression was higher in Millennium Cohort Study nondeployers (19.1% at 2004 survey and 22.4% at 2007 survey) than in Seabee nondeployers (6.0%). Millennium Cohort Study combat deployers experienced the same trend with respect to depression with elevated reporting (23.4% at 2004 survey and 27.8% at 2007 survey) when compared with Seabee deployers (17.7%). However, Seabee deployers had a higher prevalence of rash or skin ulcer (22.4%), unusual fatigue (38.9%), and short-term memory problems (39.5%) compared with both groups of deployers in the Millennium cohort.

By the end of the 2007 survey cycle, 42.5% of participants had been deployed at least 1 time in support of the operations in Iraq and Afghanistan. Baseline characteristics by deployment status are presented in Table 2. Compared with those who never deployed, a higher proportion of subjects who were deployed were men, born after 1970, never married, on active duty, and still serving in the military. Among deployers, 58.4% experienced combat exposures. As expected, combat deployers were in the occupational category of combat specialist and were mostly in the Army compared with noncombat deployers and nondeployers.

Unweighted and weighted CMI prevalence by demographic and military characteristics are presented in Table 3. Compared with the US military population in 2003, our study population had a higher proportion of women, personnel born before 1970, those of white, non-Hispanic race, those with greater than a high school education, and officers. Both the unweighted and weighted CMI prevalence increased over time. The weighted prevalence of CMI was 15.5% at baseline, 22.3% at the first follow-up, and 26.5% at the second follow-up, yielding an 11.0% increase in CMI prevalence. The subgroups with a higher prevalence of CMI over time were women, those on active duty, enlisted personnel, subjects in the Army, former service members, those deployed with combat exposure, those deployed more than 365 days, current smokers, those with alcohol-related problems, and those who screened positive for panic or other anxiety disorders, depression, or PTSD. The highest prevalence of CMI was found in those with a mental disorder, with an 18.1%–20.4% increase from baseline to second follow-up. Baseline CMI prevalence was 66.7% for those with panic or other anxiety disorders, and it increased to 86.9% by second follow-up. Similarly, those with depression had a baseline CMI prevalence of 70.1% that increased to 85.9% at first follow-up and 88.2% at second follow-up. Subjects with PTSD had a baseline CMI prevalence of 65.3% that increased by second follow-up to 85.7%.

Adjusted odds ratios for self-reported CMI symptoms are shown in Table 4. Race/ethnicity and occupation were removed from the final statistical model because these variables were not statistically significant and there was no evidence of confounding. After adjustment for history of combat exposures, CMI history, and other covariates in the final model, those who had recently been deployed and had combat exposures were 1.70 times more likely to have CMI than were nondeployed personnel (95% confidence interval: 1.63, 1.78).

Table 2.   Baseline Demographic Characteristics of Millennium Cohort Study Participants by Deployment Status, 2001 2008[a]

Characteristic	Never Deployers[b] (n = 42,001)		Deployers[c] (n = 31,077)		Deployed With Combat[c] (n = 18,155)	
	No.	%	No.	%	No.	%
Sex						
Male	27,971	66.6	24,378	78.4	14,769	81.3
Female	14,030	33.4	6,699	21.6	3,386	18.7
Birth year						
1980 or later	4,492	10.7	6,134	19.7	3,799	20.9
1970 1979	12,620	30.0	11,410	36.7	6,922	38.1
1960 1969	14,458	34.4	10,049	32.3	5,591	30.8
Before 1960	10,431	24.8	3,484	11.2	1,843	10.2
Race/ethnicity						
White, non-Hispanic	30,171	71.8	21,998	70.8	12,946	71.3
Black, non-Hispanic	5,215	12.4	3,424	11.0	1,719	9.5
Other	6,615	15.7	5,655	18.2	3,490	19.2
Educational level						
High school or less	20,247	48.2	17,130	55.1	10,681	58.8
Some college	9,611	22.9	6,275	20.2	2,815	15.5
Bachelor's degree	7,385	17.6	5,655	18.2	3,437	18.9
Advanced degree	4,758	11.3	2,017	6.5	1,222	6.7
Marital status						
Never married	13,092	31.2	12,340	39.7	7,460	41.1
Married	26,020	62.0	17,194	55.3	9,826	54.1
Previously married	2,889	6.9	1,543	5.0	869	4.8
Service branch						
Army	18,342	43.7	15,792	50.8	11,472	63.2
Navy or Coast Guard	8,797	20.9	4,532	14.6	1,812	10.0
Marine Corps	2,253	5.4	1,651	5.3	1,197	6.6
Air Force	12,609	30.0	9,102	29.3	3,674	20.2
Service component						
Active duty	21,710	51.7	19,348	62.3	11,100	61.1
Reserve/National Guard	20,291	48.3	11,729	37.7	7,055	38.9
Military pay grade						
Enlisted	31,657	75.4	23,922	77.0	13,753	75.8
Officer	10,344	24.6	7,155	23.0	4,402	24.2

Table continues

DISCUSSION

Although reporting of CMI symptoms was common among nondeployed veterans of the 1991 Gulf War, previous research has highlighted CMI reporting among deployed veterans (6, 12, 13, 36). These studies were initiated in response to concerns in the mid-1990s and were conducted using retrospective or cross-sectional study designs. In the present study, we used prospective data to address the potential for a similar diverse set of health outcomes that might be associated with recent military operations in the Gulf region. Our longitudinal study, which incorporated pre- and

postdeployment assessments, showed higher odds of CMI among subjects in the Army, women, and active-duty personnel. Although slightly less than the 2-fold increase seen among 1991 Gulf War veterans, the current study found a consistent and elevated odds of CMI (odds ratio = 1.70) among those who were deployed to Iraq and Afghanistan and also reported combat experiences. These data suggest that arduous deployments involving combat experiences place susceptible persons at higher risk for CMI within the timeframe covered by our analyses. It is also important to note that characteristics that were associated with reporting CMI, such as age, educational level, service branch, service

Table 2. Continued

Characteristic	Never Deployers[b] (n = 42,001)		Deployers[c] (n = 31,077)		Deployed With Combat[c] (n = 18,155)	
	No.	%	No.	%	No.	%
Military service status						
Current service member	38,105	90.7	30,952	99.6	18,062	99.5
Former service member	3,896	9.3	125	0.4	93	0.5
Occupation						
Combat specialist	7,013	16.7	7,222	23.2	4,959	27.3
Health care	5,858	13.9	2,406	7.7	1,908	10.5
Functional support/service and supply	12,678	30.2	7,764	25.0	4,137	22.8
Other	16,452	39.2	13,685	44.0	7,151	39.4
Smoking status						
Nonsmoker	24,601	58.6	18,060	58.1	10,114	55.7
Past smoker	10,559	25.1	7,165	23.1	4,322	23.8
Current smoker	6,841	16.3	5,852	18.8	3,719	20.5
Alcohol-related problems[d]						
No	37,249	88.7	26,991	86.9	15,499	85.4
Yes	4,752	11.3	4,086	13.1	2,656	14.6
Panic or other anxiety disorders[d]						
No	40,647	96.8	30,284	97.4	17,563	96.7
Yes	1,354	3.2	793	2.6	592	3.3
Depression[d]						
No	40,532	96.5	30,104	96.9	17,446	96.1
Yes	1,469	3.5	973	3.1	709	3.9
Posttraumatic stress disorder[e]						
No	40,034	95.3	29,742	95.7	17,117	94.3
Yes	1,967	4.7	1,335	4.3	1,038	5.7
Chronic multisymptom illness						
No	35,576	84.7	26,934	86.7	15,231	83.9
Yes	6,425	15.3	4,143	13.3	2,924	16.1

[a] Percents have been calculated for each column utilizing the population size listed at the top of the respective columns.

[b] Participants who were never deployed in support of the operations in Iraq or Afghanistan.

[c] Participants who were deployed at least once in support of the operations in Iraq or Afghanistan. These groups are not mutually exclusive.

[d] Standardized Patient Health Questionnaire scoring mechanisms were used to evaluate symptoms for alcohol-related problems, depression, and panic and other anxiety disorders.

[e] Posttraumatic stress disorder (PTSD) symptoms were evaluated based on the PTSD Checklist-Civilian Version using the *Diagnostic and Statistical Manual of Mental Disorders, 4th Edition* criteria.

component, and enlisted versus officer status, have been reported to be associated with many health outcomes (37–39). These characteristics provide populations for study that may yield resiliency factors that could be translated into benefit for the deploying populations.

Previous research on symptom reporting from a historical context found that Seabees deployed to the 1991 Gulf War were more likely to report symptoms and conditions than were their peers who either deployed to another region or were not deployed (9). Interestingly, the Seabees deployed to the Gulf War reported more symptoms than did any of the groups in the Millennium Cohort Study, regardless of

deployment status. For symptoms that were exactly matched, combat deployers from the Millennium Cohort Study had a prevalence of symptom reporting similar to that of the Seabees, although the reported prevalence of every symptom was higher in the Seabees than in the Millennium cohort except for trouble sleeping at the 2007 assessment. It is possible that because the data from the Seabee study were collected nearly 10 years after the first Gulf War, respondents had more time for symptoms to manifest or that symptom recall may have been higher among respondents because of extensive media coverage surrounding illness in Gulf War veterans. For symptoms that closely matched, Millennium Cohort

Table 3.   Weighted and Unweighted Prevalence of Chronic Multisymptom Illness in Millennium Cohort Study Participants, 2001 2008[a,b]

Characteristic	Population (*n* = 73,078)	Weighted Population[c]	Prevalence of Chronic Multisymptom Illness					
			Baseline (*n* = 73,078)	Baseline Weighted[c]	1st Follow up (*n* = 60,851)	1st Follow up Weighted[c]	2nd Follow up[d] (*n* = 49,912)	2nd Follow up Weighted[c,d]
	Column %	Column %	Row %	Row %	Row %	Row %	Row %	Row %
Overall prevalence			14.5	15.5	20.2	22.3	22.1	26.5
Sex								
Male	71.6	84.4	13.0	14.7	18.6	21.6	20.6	25.8
Female	28.4	15.6	18.1	19.6	24.4	25.9	26.5	30.1
Birth year								
1980 or later	14.5	30.8	17.9	14.5	25.4	22.4	26.1	31.9
1970 1979	32.9	33.5	14.5	15.5	20.5	22.1	22.2	25.4
1960 1969	33.5	25.8	13.6	16.1	18.8	22.2	23.1	27.0
Before 1960	19.0	9.9	13.3	16.9	17.8	22.5	19.8	24.4
Race/ethnicity								
White, non-Hispanic	71.4	66.9	14.0	15.2	19.9	22.6	21.2	26.5
Black, non-Hispanic	11.8	18.7	17.1	16.7	22.9	20.6	26.6	25.8
Other	16.8	14.4	14.8	15.4	20.0	22.7	23.1	27.1
Educational level								
High school or less	51.1	80.1	18.2	16.6	23.5	23.2	25.0	27.1
Some college	21.7	5.8	13.2	12.0	25.5	16.6	28.1	20.9
Bachelor's degree	17.8	9.5	8.8	8.2	14.0	12.0	18.3	19.4
Advanced degree	9.3	4.6	7.5	15.9	11.1	33.4	14.1	36.3
Marital status								
Never married	34.8	47.2	14.8	14.3	21.2	21.2	22.6	25.1
Married	59.1	48.8	14.0	16.4	19.2	22.1	21.2	25.9
Previously married	6.1	4.0	17.5	18.5	26.2	28.3	28.1	32.3
Service branch								
Army	46.7	52.6	17.9	18.6	24.8	27.1	27.8	31.6
Navy or Coast Guard	18.2	19.3	12.0	13.3	16.7	18.2	18.0	21.3
Marine Corps	5.3	7.9	16.6	17.5	23.9	27.4	22.5	24.2
Air Force	29.7	20.2	10.2	8.8	14.3	11.8	16.2	16.5
Service component								
Active duty	56.2	56.7	16.7	18.8	22.3	25.4	24.0	29.7
Reserve/National Guard	43.8	43.3	11.6	11.2	18.4	18.3	20.4	22.4
Military pay grade								
Enlisted	76.1	89.8	16.6	16.6	23.7	23.8	25.9	27.4
Officer	24.0	10.2	7.6	6.2	10.7	9.3	13.8	17.2
Military service status								
Current service member	94.5	94.7	13.9	14.9	18.8	20.8	20.2	24.5
Former service member	5.5	5.3	24.2	26.8	28.6	31.2	28.0	32.1
Occupation								
Combat specialist	19.5	18.6	12.9	16.6	18.2	25.3	19.4	27.0

Table continues

Study combat deployers reported a higher prevalence of pain in the arms, legs, or joints; feeling down, depressed, or hopeless; and feeling nervous, anxious, or on edge or worrying a lot about different things. Higher reporting of these symptoms might be the result of survey instrument wording for these questions, that is, a question encompassing multiple feelings or symptoms, which may have led to greater endorsement of these items. Also, any differences in reporting of symptoms among veterans of these 2 operations highlight the fact that these were 2 very different conflicts, with occupational

Table 3. Continued

Characteristic	Population (n = 73,078)	Weighted Population[c]	Prevalence of Chronic Multisymptom Illness					
			Baseline (n = 73,078)	Baseline Weighted[c]	1st Follow up (n = 60,851)	1st Follow up Weighted[c]	2nd Follow up[d] (n = 49,912)	2nd Follow up Weighted[c,d]
	Column %	Column %	Row %	Row %	Row %	Row %	Row %	Row %
Health care	11.3	8.2	13.2	13.8	18.5	18.3	21.6	26.6
Functional support/ service and supply	28.0	26.1	16.0	17.1	21.4	22.6	23.4	25.9
Other	41.2	47.2	14.5	14.4	20.8	21.6	22.6	26.6
Combat experience								
Nondeployed	88.2	83.0	14.0	14.9	19.4	21.1	21.9	26.0
Deployed without combat	4.8	6.0	10.9	11.1	15.2	13.7	15.3	17.7
Deployed with combat	7.1	11.0	22.8	22.3	28.3	32.0	29.7	35.4
Cumulative length deployed, days								
0	88.1	82.8	14.0	14.9	19.4	21.1	21.8	26.0
1–180	7.0	9.3	14.2	13.7	19.0	20.7	17.5	21.1
181–365	3.9	6.1	22.6	23.3	24.0	25.9	25.9	30.8
>365	1.0	1.7	27.2	26.1	26.7	28.2	28.0	29.3
Smoking status								
Nonsmoker	58.4	56.5	11.6	11.9	16.7	17.2	18.7	22.5
Past smoker	24.3	22.3	16.4	17.8	22.6	26.8	24.9	29.4
Current smoker	17.4	21.2	21.2	22.7	29.3	31.2	31.6	34.0
Alcohol-related problems[e]								
No	87.9	85.2	13.5	14.1	18.8	19.9	20.9	24.3
Yes	12.1	14.8	21.8	23.3	35.1	38.6	36.1	43.5
Panic or other anxiety disorders[e]								
No	97.1	96.5	12.7	13.7	17.6	19.0	19.4	22.8
Yes	2.9	3.5	72.7	66.7	80.3	83.6	83.0	86.9
Depression[e]								
No	96.7	96.1	12.5	13.3	17.7	18.6	19.5	22.8
Yes	3.3	3.9	72.6	70.1	82.1	85.9	85.8	88.2
Posttraumatic stress disorder[f]								
No	95.5	94.6	12.0	12.6	16.7	17.3	18.6	21.3
Yes	4.5	5.4	66.4	65.3	77.2	80.8	83.2	85.7

[a] Population includes only persons with complete covariate data at baseline.

[b] Percents have been calculated for each row.

[c] Weights were computed using an inverse-response method. Population was weighted on sex, birth year, race/ethnicity, educational level, and pay grade.

[d] Only includes participants from panel 1. Data for panel 2 at second follow-up have not yet been collected.

[e] Standardized Patient Health Questionnaire scoring mechanisms were used to evaluate symptoms for depression and panic and other anxiety disorders.

[f] Posttraumatic stress disorder (PTSD) symptoms were evaluated based on the PTSD Checklist-Civilian Version using the *Diagnostic and Statistical Manual of Mental Disorders, 4th Edition* criteria.

exposures and combat tactics that were unique to each. We offer this comparison because of what might be learned from the differences and similarities in exposures and subsequent reporting of symptoms that meet the Centers for Disease Control and Prevention definition of CMI. The prevalence of symptom reporting in the current study was highest among those who were deployed and reported combat exposures and lowest among those who were deployed but did not report combat exposures. Nondeployed individuals were in between those groups. This finding has been observed in previous Millennium Cohort Study research related to other health outcomes, such as PTSD (22, 38), depression (39),

Table 4.   Adjusted Odds of Reporting Symptoms of Chronic Multisymptom Illness in Millennium Cohort Study Participants (2001 2008)

Characteristic	Chronic Multisymptom Illness		
	Adjusted OR[a]	95% CI	P Value
Sex			<0.0001
Male	1.00	Referent	
Female	1.43	1.37, 1.48	
Birth year			<0.0001
1980 or later	1.00	Referent	
1970 1979	0.96	0.91, 1.03	
1960 1969	1.18	1.10, 1.26	
Before 1960	1.22	1.12, 1.31	
Educational level			<0.0001
High school or less	1.00	Referent	
Some college	0.93	0.88, 0.98	
Bachelor's degree	0.79	0.74, 0.84	
Advanced degree	0.70	0.64, 0.77	
Marital status			0.0126
Never married	0.94	0.90, 0.98	
Married	1.00	Referent	
Previously married	1.03	0.97, 1.10	
Service branch			<0.0001
Army	1.00	Referent	
Navy or Coast Guard	0.67	0.64, 0.70	
Marine Corps	0.86	0.80, 0.93	
Air Force	0.64	0.61, 0.67	
Service component			<0.0001
Active duty	1.00	Referent	
Reserve/National Guard	0.80	0.77, 0.83	
Military pay grade			<0.0001
Enlisted	1.00	Referent	
Officer	0.66	0.62, 0.70	
Military service status			<0.0001
Current service member	1.00	Referent	
Former service member	1.22	1.16, 1.27	
History of deployment[b]			<0.0001
Nondeployer	1.00	Referent	
Deployed	0.95	0.89, 1.01	
Combat deployed	1.25	1.18, 1.32	

Table continues

Table 4.   Continued

Characteristic	Chronic Multisymptom Illness		
	Adjusted OR[a]	95% CI	P Value
Current deployment[b]			<0.0001
Nondeployer	1.00	Referent	
Deployed	0.89	0.85, 0.94	
Combat deployed	1.70	1.63, 1.78	
Smoking status			<0.0001
Nonsmoker	1.00	Referent	
Past smoker	1.17	1.13, 1.22	
Current smoker	1.32	1.26, 1.38	
Alcohol-related problems[c]			<0.0001
No	1.00	Referent	
Yes	1.14	1.08, 1.20	
Panic or other anxiety disorders[c]			<0.0001
No	1.00	Referent	
Yes	1.62	1.47, 1.79	
Depression[c]			<0.0001
No	1.00	Referent	
Yes	1.45	1.32, 1.60	
Posttraumatic stress disorder[d]			<0.0001
No	1.00	Referent	
Yes	1.98	1.82, 2.15	
History of CMI			<0.0001
No	1.00	Referent	
Yes	5.44	5.23, 5.67	

Abbreviations: CI, confidence interval; CMI, chronic multisymptom illness; OR, odds ratio.

[a] CMI model was adjusted for all variables listed in the table. Other variables were removed from the final model because they were not significant at the $P < 0.05$ level and not confounding (race/ethnicity and occupation).

[b] Current deployment was assessed in the 3 years before completing the survey, whereas history of deployment was assessed in the 3 6 year period before completing the survey. Both deployment variables were in support of the recent operations in Iraq and Afghanistan.

[c] Standardized Patient Health Questionnaire scoring mechanisms were used to evaluate symptoms for alcohol-related problems, depression, and panic and other anxiety disorders.

[d] Posttraumatic stress disorder (PTSD) symptoms were evaluated based on the PTSD Checklist-Civilian Version using the *Diagnostic and Statistical Manual of Mental Disorders, 4th Edition* criteria.

hypertension (40), headache disorders (41), diabetes (42), functional health (43), and alcohol misuse (44). Also, it is plausible that exposure to combat is emotionally traumatic and might increase symptom reporting. This phenomenon was noted by another research team studying CMI among deployed veterans of the first Gulf War after a 10-year interval (6). They estimated that the prevalence of CMI among deployed veterans was double that among nondeployed veterans,

which we did not observe. It is possible that because our data collection was closer to the time of deployment, CMI symptoms may not have had sufficient time to manifest. However, the prevalence of symptom reporting increased slightly across all Millennium Cohort Study groups during the second time interval between surveys (2004–2007). Although the 2 time points do not specifically capture pre- and postdeployment symptom reporting, an increase in CMI symptom reporting

among those who were deployed could be related to the experience of multiple deployments by the end of the second time interval. In nondeployed individuals, the increase in symptom reporting may be due to increasing age or increased cumulative time of exposure to occupational rather than deployment-related experiences. It was also noteworthy that trouble sleeping was highly prevalent, especially among combat deployers. A previous investigation of sleep problems in the cohort showed that deployed personnel reported trouble sleeping during and after deployment more often than did those who did not deploy, and this relationship was mediated by combat exposures (45).

There are several limitations to this study. Our study population consisted of a sample of Millennium Cohort Study participants and might not be completely representative of the military population in general. However, investigation of several key potential biases in the Millennium Cohort Study have found the cohort to be mostly representative, specifically with respect to health-care utilization before study enrollment among responders compared with nonresponders and reliable reporting of data by study participants (20, 46–54). Further, a complete case analysis approach was conducted and might present a nonresponse bias. However, debate continues over best practices (55), and a recent report suggested minimal practical differences in measures of effect after propensity adjustment for nonresponse (56), The PTSD Checklist-Civilian Version and Patient Health Questionnaire were used to assess mental health disorders, and although they are standardized and validated instruments, they are surrogates for a clinician's diagnosis and might therefore misclassify mental health status. The Centers for Disease Control and Prevention case definition requires CMI symptoms to be present for at least 6 months. The Millennium Cohort Study questionnaires, however, assessed these symptoms over a shorter time frame, which may have led to overestimation of the prevalence of CMI in this population. It is important to note that a similar CMI prevalence was reported in other studies (6). Still, it remains a limitation that underreporting of these symptoms in personnel with a current-duty status may be caused by the potential stigma attached to these symptoms. Discrepancies in CMI classification could also be due to the presence of other symptom-based conditions, such as chronic fatigue syndrome, fibromyalgia, and irritable bowel syndrome, because these often occur as comorbid conditions (6, 57). Using a highly specific or standardized definition for CMI could lessen this association. Other reported comorbid conditions were not included in these analyses because of the absence of temporal sequence and a potential for overadjustment, although consideration of comorbid conditions is an important area for further study (33, 58). Lastly, follow-up assessment time points that are on average 3 years apart might not represent the appropriate timeframes in which to assess a health outcome such as CMI and may not present enough time for the symptoms to appear in some cases. Further, previous time spent in the Gulf War cannot be assessed in the cumulative time deployed to this theater. Both of these potential limitations might bias the results towards the null and thus reduce measures of effect sizes reported here.

Despite these limitations, the present study has a number of important strengths. To our knowledge, it is the first study to prospectively analyze the relationship between CMI and deployment in a large population-based military cohort. This cohort consists of participants from all military services branches and includes active duty, Reserve, and National Guard members, as well as service members who have left the military. The longitudinal study design of the Millennium Cohort Study allows for a baseline behavioral and health assessment before deployment. As many individuals with mental health disorders may not seek treatment, responses to PTSD Checklist-Civilian Version and Patient Health Questionnaire screens might more accurately reflect the prevalence of mental health symptoms than estimates based on actual clinical diagnosis or hospitalization data. Symptoms of CMI might also be better captured through self-report.

In summary, these data highlight a difference in CMI reporting when comparing deployed to nondeployed military members, although symptom reporting in this contemporary cohort occurred less frequently than in the historical 1991 Gulf War cohort. Despite the difficulty of assigning a definitive medical diagnosis, these self-reported symptoms offer a glimpse of the comorbid conditions associated with deployment and should be followed-up to characterize either the transient nature of increased symptom reporting or the transition in some individuals to chronic illness. Developing a true case definition of CMI is imperative for clinical practice. However, until then, increasing our understanding of coping skills and resilience after emotional trauma and incorporating CMI-related symptoms into clinical screening tools for service members returning from deployment might help identify persons who are candidates for follow-up and/or interventions to reduce the possibilities of chronic illness manifestations.

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REPORT DOCUMENTATION PAGE

1. REPORT DATE (DD MM YY) 11-09 14	2. REPORT TYPE Journal Article	3. DATES COVERED (from – to) 2001-2008

4. TITLE Chronic Multisymptom Illness: A Comparison of Iraq and Afghanistan Deployers with Veterans of the 1991 Gulf War	5a. Contract Number:
	5b. Grant Number:
	5c. Program Element Number:
	5d. Project Number: NHRC.2000.0007
6. AUTHORS Smith, Tyler C.; Teresa M. Powell, Isabel G. Jacobson, Besa Smith, Tomoko I . Hooper, Edward J. Boyko & Gary D. Gackstetter	5e. Task Number:
	5f. Work Unit Number: 60002

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Commanding Officer Naval Health Research Center 140 Sylvester Rd San Diego, CA 92106-3521	8. PERFORMING ORGANIZATION REPORT NUMBER 14-39

8. SPONSORING/MONITORING AGENCY NAMES(S) AND ADDRESS(ES) Commanding Officer Chief, Bureau of Medicine and Surgery Naval Medical Research Center 7700 Arlington Blvd 503 Robert Grant Ave Falls Church, VA 22042 Silver Spring, MD 20910-7500	10. SPONSOR/MONITOR'S ACRONYM(S) BUMED/NMRC
	11. SPONSOR/MONITOR'S REPORT NUMBER(s)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution is unlimited.

13. SUPPLEMENTARY NOTES

14. ABSTRACT
Symptoms and illness reported from the Gulf War era are a cause of potential concern for those military members who have deployed to the Gulf region in support of contingency operations in Iraq and Afghanistan. This study quantified self-reported symptoms from Millennium Cohort participants, enrolled in a prospective study representing all US service branches, active duty and Reserve/Guard components, from 2001-2008. Self-reported symptoms were uniquely compared to a cohort from the 1991 Gulf War to gain context for the current report. Symptoms were then aggregated to identify cases of chronic multisymptom illness (CMI) based on the Centers for Disease Control and Prevention case definition. The prevalence of self-reported CMI symptoms was compared to those from a study population of US Seabees from the 1991 Gulf War collected in 1997-1999, as well as deployed and non-deployed subgroups. Although overall symptom reporting was much less than in the 1991 Gulf War cohort, increased CMI reporting was noted among deployed compared to non-deployed contemporary Cohort members. An increased understanding of coping skills and resilience, and well-designed screening instruments, along with appropriate clinical and psychological follow-up for returning veterans, may help to focus resources on early identification of potential long-term chronic disease manifestations.

15. SUBJECT TERMS
Symptom self-reporting; Multisymptom illness in Gulf War Veterans; Gulf War Syndrome

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	18a. NAME OF RESPONSIBLE PERSON
a. REPORT UNCL	b. ABSTRACT UNCL	c. THIS PAGE UNCL	UNCL	13	Commanding Officer
					18b. TELEPHONE NUMBER (INCLUDING AREA CODE) COMM/DSN: (619) 553-8429

Standard Form 298 (Rev. 8-98)
Prescribed by ANSI Std. Z39-18